THE UPPER MISSISSIPPIAN AMMONOID *DELEPINOCERAS* IN NORTH AMERICA

by W. M. FURNISH, J. H. QUINN, and JAMES A. MCCALEB

ABSTRACT. The occurrence of a late Mississippian cephalopod, the genus *Delepinoceras*, is reported from Arkansas and Oklahoma. This fossil, not previously described from the Western Hemisphere, indicates precise correlation of the upper Chester Series and the late lower Namurian of Eurasia and Africa.

UNTIL 1958, knowledge of the ammonoid *Delepinoceras* rested on three specimens from two localities; one of the records was of an uncertain nature. In the past few years representatives of the same genus have been discovered at seven additional localities scattered around the world. This distinctive ammonoid also appears to have evolved so rapidly and to have become extinct in such a short span that it is restricted to a narrow time zone. The stratigraphic range of the genus will probably prove to be somewhat greater than is now apparent, but the fossil will also serve as a useful index in Mississippian–Pennsylvanian boundary strata.

The importance of *Delepinoceras* was realized by Ruzhencev who assigned the taxon to a separate family in 1957 and who described an occurrence from the southern Urals in 1958. A specimen from the questionable Springer Formation in Oklahoma (Branson 1962, p. 433) was 'rediscovered' in our collections after the appearance of Ruzhencev's analysis. While this occurrence in Oklahoma was being checked, another example appeared in material from Arkansas. In addition, accounts by Kullmann (1962), Wagner-Gentis (1963), and by Pareyn (1962) have added to our knowledge of the geographic range of this genus.

STRATIGRAPHY

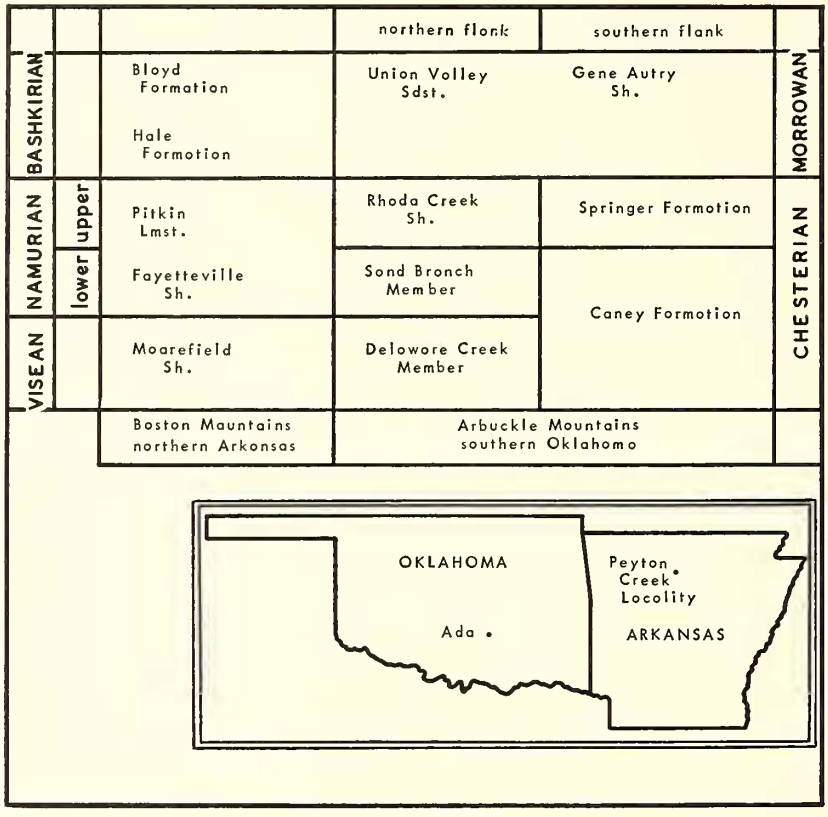
In north-western Arkansas and adjacent Oklahoma, the uppermost Mississippian formation is the Pitkin Limestone, the type locality for which is in Washington County. This unit is typically a limestone of some 50 feet thickness bounded by unconformities. In north-central Arkansas, 150 miles to the east, thicker strata with a similar stratigraphic position in the Leslie area of southern Searcy County and northern Van Buren County cannot be correlated lithologically with any particular part of the Pitkin, but are regarded as an approximate equivalent (Easton 1942). The upper 100 feet of predominantly shaly strata in the 200-foot shale and limestone section of this vicinity are known as the 'Peyton Creek beds' of the upper Pitkin Formation. A typical development is found at an exposure in Frank Stewart's Peyton Creek Phosphate Mining Company strip mine about 5 miles south of Leslie (Sec. 12, T. 13 N., R. 15 W.) but across the county line in northern Van Buren County. Another exposure is found nearby in a road cut on U.S. Highway 65 about $\frac{1}{4}$ mile south of the bridge over Peyton Creek.

An abundant molluscan fauna occurs in the Peyton Creek beds at the type locality. Loose fossils are secured from the shales and phosphate-rich layers. Well-preserved

[Palaeontology, Vol. 7, Part 2, 1964, pp. 173–80, pl. 30.]

goniatites include *Delepinoceras*, *Anthracoceras*, *Cravenoceras*, *Eumorphoceras*, and *Dimorphoceras* (Quinn 1962*b*). The nautiloid genera *Brachycycloceras*, *Tylonautilus*, and *Stroboceras* are also represented. Gastropods and pelecypods are abundant; brachiopods and crinoids are relatively rare.

In the Leslie, Arkansas, vicinity there are lithologic variations within the Peyton



TEXT-FIG. 1. Correlation chart of mid-continent goniatite-bearing strata in Upper Mississippian and Lower Pennsylvanian.

Creek beds, especially across the depositional strike. The upper fossiliferous beds at Peyton Creek south of Leslie are not associated with a completely exposed Pitkin section, although about 170 feet of strata crop out. East of Leslie on State Highway 66 (SE $\frac{1}{4}$ Sec. 23, T. 14 N., R. 15 W.) the Fayetteville Shale and 200 feet of younger Mississippian are exposed along the road. Above the Fayetteville, the basal 40 feet of section is a massive limestone; this unit is succeeded by a similar thickness of dark calcareous shale. Above the shale is a bed of conglomeratic limestone 6 feet thick which contains an abundance of large *Eumorphoceras bisulcatum*; specimens as large as 200 mm. diameter have been obtained.

About 120 feet of exposed strata overlie the *Eumorphoceras bisulcatum* horizon in the road section east of Leslie. These upper layers include limestone, shale, and sandstone, most of which are correlated with the 'Peyton Creek shale' locality 5 miles to the south. At the top of the Leslie section there is a limestone grading into calcareous conglomerate above. This upper bed is overlain by about 4 feet of fine-grained sandstone and then some 5 feet of coarse conglomerate containing pebbles and granules of phosphatic material. The phosphatic conglomerate may be of Pennsylvanian age and is believed to represent a hiatus.

CORRELATIONS

In Arkansas, the strata underlying the Peyton Creek *Delepinoceras* beds are of Fayetteville and lower Pitkin age. These strata contain normal *Eumorphoceras* Zone fossils, the *Eumorphoceras-Paracravenoceras-Cravenoceras* assemblage, which occur in the Sand Branch Member of the Caney Shale in southern Oklahoma. Equivalent strata in Europe are of lower Namurian (Pendleian–Arnsbergian) age. According to Collinson, Scott, and Rexroad (1962, chart 5) a correlation of conodont faunas with European goniatite zones indicates that these strata represent middle and upper Chester of the type area. Over fifty years ago, Willis (1912, p. 411–12) presented the same general correlation. Also, in terms of various interpretations of subsequent years (e.g. Moore 1937, p. 31; 1948, p. 398, and Weller *et al.* 1948), this correlation represents a majority opinion. However, other authorities (e.g. Miller, *in* Weller *et al.* 1948, p. 117) have expressed widely different conclusions.

The next younger goniatite fauna includes *Delepinoceras*, *Anthracoceras*, *Cravenoceras*, and *Eumorphoceras* in the Arkansas sequence (Quinn 1962*b*). The fauna appears to fall within the uppermost *Eumorphoceras* Zone, lower Namurian, of Europe (Ruzhencev 1962, Kullmann 1962, Pareyn 1962). On the basis of conodont faunas primarily, Collinson, Scott and Rexroad (1962, p. 27) correlated the uppermost type Chester (Kinkaid) with the European middle Namurian *Homoceras* Zone. Relatively few 'middle' Carboniferous conodont faunas are known in Europe, but Clarke (1960) has described some from Scotland, and Higgins (1961, 1962) records a few species from Staffordshire and northern Spain. Circuitously, it appears that the *Delepinoceras* beds in Arkansas and Oklahoma are probably of latest Chesterian age. If this interpretation is correct, the Springeran (Elias 1956, 1960) lies within the Mississippian and is not a separate stage.

Above the Arkansas Chesterian is the type Morrowan. The basal unit, the Hale Formation, contains abundant *Verneuilites sp.* as well as *Baschkirites* cf. *discoidalis* Librovitch and is correlated with the lower part of the Bashkirian (Westphalian) Stage in Europe. The Bloyd Formation, upper Morrowan, contains *Gastrioceras*, *Brannero-ceras*, *Diaboloceras*, and *Axinolobus*, and is a faunal correlative of the *Gastrioceras* Zone, also within the Bashkirian Stage.

In southern Oklahoma, the Morrowan section contains Bloyd ammonoid faunas in the Union Valley Sandstone (Quinn 1962*a*, p. 116) and the Gene Autry Shale. On the north flank of the Arbuckle Mountains, the Union Valley assemblage contains *Gastrio-ceras* and *Brannero-ceras*. South of the main Arbuckle uplift, a slightly younger goniatite fauna in the Gene Autry Formation includes *Axinolobus* and *Diaboloceras*. The Hale ammonoid fauna has not been identified with certainty in this general area.

SYSTEMATIC DESCRIPTION

Genus DELEPINOCERAS Miller and Furnish 1954

Type species. *Dimorphoceras thalassoide* Delépine, *in* Delépine and Menchikoff 1937, p. 83.

1937 *Dimorphoceras* (part) Delépine *in* Delépine and Menchikoff, pp. 83–85.
1941 *Dimorphoceras* (part) Delépine, p. 75.
1951 *Eothalassoceras* (part) Miller *in* Barker, p. 179.
1954 *Delepinoceras* Miller and Furnish, p. 690.
1957, Miller and Furnish, p. 69. 1957, Ruzhencev, p. 58.
1958*a*, Ruzhencev, pp. 28, 29. 1958*b*, Ruzhencev, pp. 489–92.
1960, Ruzhencev, p. 211. 1960, Kullmann, pp. 336–7.
1962, Pareyn, p. 134. 1962, Ruzhencev, p. 375.
1963, Wagner-Gentis, p. 15.

The most distinctive feature of the genus *Delepinoceras* is the nearly symmetrical threefold subdivision of the lateral lobes and prongs of the ventral lobe in the suture. This feature appears during ontogeny at about 15 mm. diameter. The conch is subdiscoidal at maturity with an evenly rounded venter and nearly closed umbilicus. Growth lines are almost straight but biconvex; reticulate sculpture is present as well as constrictions on immature whorls.

Delepinoceras was initially recorded from the Algero–Moroccan border and the Pyrenees; additional specimens have been described since from these areas. Several specimens were secured in the southern Urals, and we are recording the genus in the southern mid-continent of the United States. Mackenzie Gordon, Jr. (personal communication, 1962), has stated that he has also found the genus in the Great Basin. In most of these cases, only a relatively small number of specimens or isolated shells have been reported, but it appears that the stratigraphic level is uppermost Mississippian (late Chesterian) or equivalent (upper *Eumorphoceras* Zone). Another species, *D. eothalassoides* Wagner-Gentis (1963, p. 15), is now known from the lower *Eumorphoceras* Zone (middle Chesterian). Earlier ancestors were probably Late Mississippian goniatitids, such as *Platygoniatites*, which are closely similar except for the secondary elements (Ruzhencev 1960, p. 210); no obvious descendants have been recognized.

The Dimorphoceratidae and the Thalassoceratidae evolved at about the same time as the Delepinoceratidae and all demonstrate at least superficial resemblance to one another. Neither of those two families, however, contain representatives in which trifid lobes are stabilized. *Dimorphoceras* possesses bifid or irregularly subdivided lobes, and in *Thalassoceras* the lobes are serrate or irregularly digitate.

Delepinoceras bressoni Ruzhencev 1958

Plate 30, figs. 1–5

1951 *Eothalassoceras sp.* Miller *in* Barker, p. 179.
1956 *Eothalassoceras sp.* Miller; Elias, p. 94.
1958 *Delepinoceras bressoni* Ruzhencev, pp. 490–2, text-figs. 1, 2.
1960 *Delepinoceras bressoni* Ruzhencev, p. 211.
1962 *Delepinoceras bressoni* Ruzhencev, p. 375.
1962 *Delepinoceras bressoni* Ruzhencev; Kullmann, p. 337.
1962 *Delepinoceras bressoni cantabricus* Kullmann, pp. 337–41, pl. 6, figs. 5–7.

D. bressoni was well illustrated and described by Ruzhencev (1958*b*). The taxon is represented in our collections by two specimens from north-central Arkansas and two from southern Oklahoma. Both of our larger shells (Pl. 30, figs. 4, 5) are estimated to have had a diameter of about 120 mm. The illustrated fragment represents part of a septate whorl some 75 mm. in diameter, with a conch height of 40 mm., a width of about 32 mm. (estimated), and an approximate umbilical diameter of 10 mm. A third specimen (Pl. 30, figs. 1, 2) is 41 mm. in diameter with a height of 24 mm., width of 23 mm., and umbilical diameter of 4·5 mm. The width/diameter proportions of 43 per cent. and 55 per cent. are similar to those in the type.

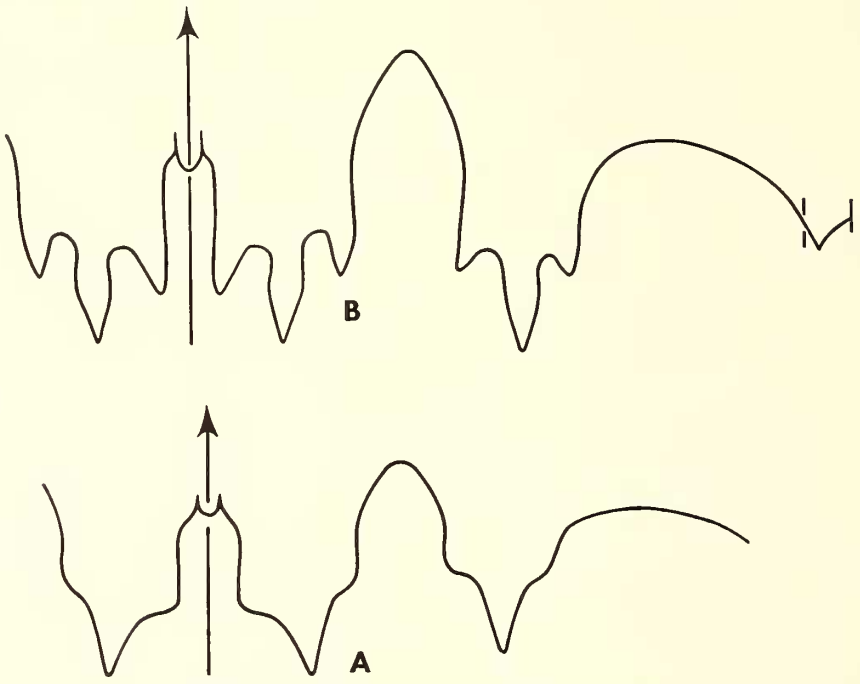
Our material consists of internal moulds and the sutures are clearly visible. The Oklahoma specimens also retain enough of the shell to verify observations by Ruzhencev; the growth lines are relatively straight but with perceptible lateral and ventral sinuses. At about 10 mm. diameter the surface of the test shows reticulate sculpture with the transverse lirae more pronounced than the longitudinal. Moderately prominent, nearly straight constrictions traverse the adolescent conch, three per whorl. The prominently ornamented interior shell surface illustrated by Ruzhencev (1958*b*, text-fig. 1*d*) has been observed on one Arkansas specimen.

Remarks. There is some uncertainty regarding the specific relationships of the type species of the genus *Delepinoceras*. One of the two specimens of *D. thalassoides* from Haci Diab described by Delépine (*in* Delépine and Menchikoff, 1937, pp. 83–85) may not be congeneric, judging by shell sculpture. The smaller individual with visible suture (ibid., pl. 5, fig. 7) is hereby designated the holotype. This type specimen at about 18 mm. diameter possesses an incipiently trifid prong of the ventral lobe and a less prominently subdivided lateral lobe (text-fig. 2A). There appears to be little difference between the suture of this form and the paratypes of *D. bressoni* illustrated by Ruzhencev (1958*b*, text-fig. 2) at comparable growth stages. However, according to the original figure of the suture, *D. thalassoides* is distinctly more advanced than *D. bressoni*. A reappraisal based on the plate photograph indicates that differences are very slight, and perhaps the prior name should serve for all. The differentiation of the subspecies *cantabricus* by Kullmann is based primarily upon minor differences in form of the conch, a lateral dimension, which is likely to be influenced by changes during preservation. In any case, the two specimens available from Oklahoma are undistorted and appear to be identical with those illustrated by Ruzhencev. The specimen from Arkansas is obviously crushed and larger, but conforms otherwise.

D. eothalassoides Wagner-Gentis has been interpreted as distinctly more primitive than *D. thalassoides* Delépine or *D. bressoni* Ruzhencev; in addition, it has been found in older strata. The stage of sutural development in *D. eothalassoides* at 35 mm. diameter is comparable to that in *D. bressoni* at 15–20 mm. Also, the prominently striate test indicates closer affinity with a goniatitid ancestry.

Occurrence. The species *D. bressoni* was described from lower Namurian strata in the Aktyubinsk region of the southern Urals; large collections of associated ammonoids are now being monographed by Ruzhencev. Kullman's ten specimens were secured from the Cantabrian Cordillera, the Asturian coast and inland in Leon Province. In northern Spain, the containing beds are correlated with the upper *Eumorphoceras* Zone and contain *Eoasianites*, *Proshumardites*, and '*Praedaraelites*' in association. In Arkansas, the

specimens were found together with an abundant goniatite fauna including *Anthracoceras*, *Eumorphoceras*, and *Cravenoceras* (Quinn 1962). These beds are at the top of the Chester section in Van Buren County, Arkansas, and should be referred to as the Peyton Creek beds. The fossils have been found in the Frank Stewart Phosphate Mine stripping operation on the south side of Peyton Creek and in a nearby highway cut, about 5 miles south of Leslie (Sec. 12, T. 13 N., R. 15 W.).



TEXT-FIG. 2. External sutures of *Delepinoceras*.

A. *D. thallassoides* Delépine, based on the holotype from Haci Diab, Algero–Moroccan borderland, at a diameter of about 18 mm. This specimen is from the lower Tagnana Stage or Zone S^{4c}, according to Pareyn (1962). The drawing is based primarily upon the photograph published by Delépine (*in* Delépine and Menchikoff 1937, pl. 5, fig. 7). ×6.

B. *D. bressoni* Ruzhencev, based on a hypotype (University of Arkansas) from the upper Chesterian at Peyton Creek, Van Buren County, Arkansas, at a diameter of about 75 mm. ×2.

Two specimens were secured from concretions in shale on the flank of the Arbuckles, Pontotoc County, Oklahoma. The horizon is in the vicinity of the type section of the Rhoda Creek Member of the Springer Formation. Barker (1951, p. 178) collected one

EXPLANATION OF PLATE 30

Figs. 1–5. *Delepinoceras bressoni* Ruzhencev. 1, 2, Two views of a specimen (SUI 10986) from Rhoda Creek Shale, in the upper portion of the Springer Formation, near the type locality of the member, south-east of Ada, Pontotoc County, Oklahoma. ×2. 3, Another specimen (SUI 11258) from the same general locality to show immature inner whorls. ×4. 4, 5, Two views of a specimen (University of Arkansas) from Peyton Creek beds in Peyton Creek, Van Buren County, south of Leslie, Arkansas. ×2.

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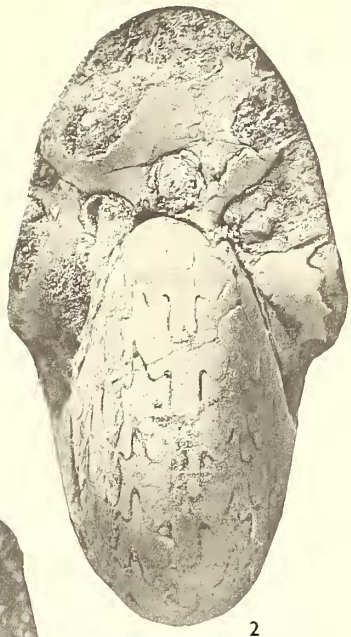

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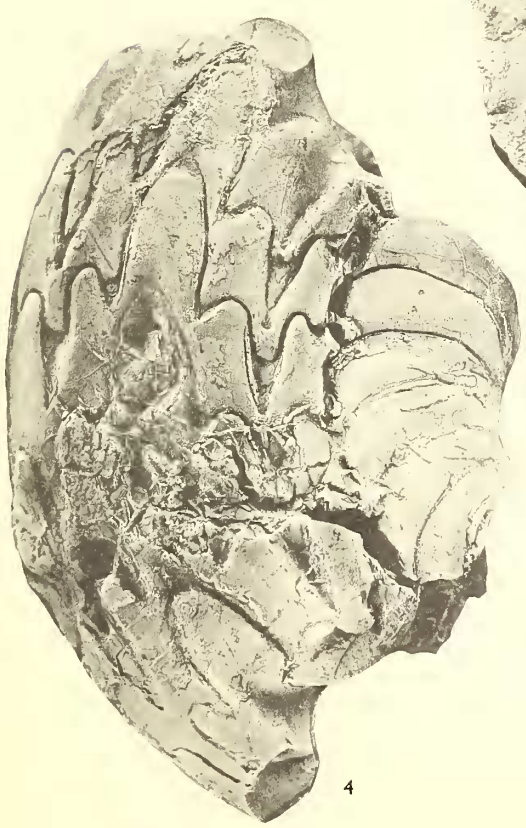

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FURNISH, QUINN and McCALEB, *Delepinoceras*